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ニシン卵の受精の研究. VI.
裸卵の受精について

柳町隆造
(北海道大学理学部動物学教室)

Studies of fertilization in *Clupea pallasi*—VI.
Fertilization of the egg deprived of the membrane

Ryuzo YANAGIMACHI
(Zoological Institute, Hokkaido University, Sapporo)

まえがき

魚卵は正常な条件の下では，通常1個の精子しか受けいれない。ニシン卵もこの例外ではない（柳町 '57 c)。では，この1個の精子しか受けいれないと云う機構は卵のどこに存在するのであろうか。もし卵の原形質にこのような機構があるならば，卵は卵膜の有無に関係なく1個の精子しか受けいれない筈である。又もし卵膜の方にこのような機構があるならば，卵から卵膜を除去してしまえば1個以上の精子が入る，即ち多精現象が起る筈である。筆者はこれらの点を明らかにするため二，三の実験を行なつてみた。

方法

実験媒液： 前報（柳町 '53, '57 a）で述べたように，ニシンの未受精卵は等張リンゲル液中で長時間受精力を保ち，しかもこの中で正常に受精し発生することができる。それで，卵の処理や媒精は一切この溶液中で行うようにした。用いた等張リンゲル液の組成は，M/4.5 NaCl 100部+M/4.5 KCl 3.5部+M/6.7 $CaCl_2$ 1.5部+M/6.7 $MgCl_2$ 2.4部で，その pH は 7.6（少量の $NaHCO_3$ で調整）であつた。

卵膜を除去する方法： 眼科用の鋏を使つて未受精卵の卵膜の一部を切りとつてから卵を静かに圧迫し，卵体を卵膜の切れ目から押しだした（Fig. 1)。なれないうちは，操作の途中で卵の表層に傷をつけてしまつたが，なれるに従い多数のものを無傷のまゝ取りだせるようになつた。操作の途中で傷を受けた卵は，数分以内に表層変化（表層胞の崩壊）を起すが，無傷のまま取りだされたものは外部から刺戟を与えない限り，いつまでも表層変化を起さないでいた。受精卵や賦活卵も，上に述べたと同じ方法で裸にすることができた。この場合には卵膜と卵体の間に隙間（囲卵腔）があるので，操作は非常に楽であつた。裸卵を一つの容器から他の容器に移すには，先の太いピペットを用いた。

結果

1. 未受精卵の場合 上に述べた方法で裸にした未受精卵，数個を精子浮游液（等張リンゲル液に新鮮な精子を約 1/2,000 の濃度にとかしたもの）に移したところ，卵は間もなく表層変化*

* 表層胞の崩壊開始は，対照の正常卵では媒精後約3分目（10°C にて）であつたが，裸卵の場合には卵によつてかなりの変異がみられた。早いものは対照卵と同じく約3分目に，遅いものは10～20分目に初めて崩壊を開始した。しかし，何れの場合にも表層胞の崩壊が始まるのは動物極で，終るのは植物極であつた。

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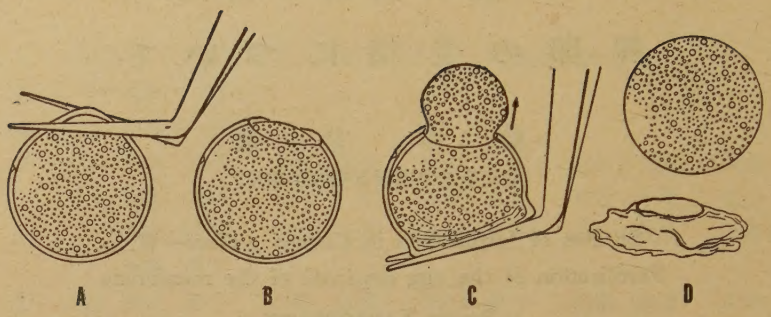

Fig. 1. Removal of the egg-membrane by the use of iridectomy scissors.
An unfertilized egg was put in a Petri-dish containing isotonic Ringer's solution ; the egg became firmly attached to the bottom of the dish owing to the adhesiveness of the membrane. Then, the membrane of the egg was partially cut off by the use of iridectomy scissors (**A—B**), and the egg proper was forced out of the membrane through the cut (**C—D**). The egg-membrane of the fertilized egg could be removed by the same method.

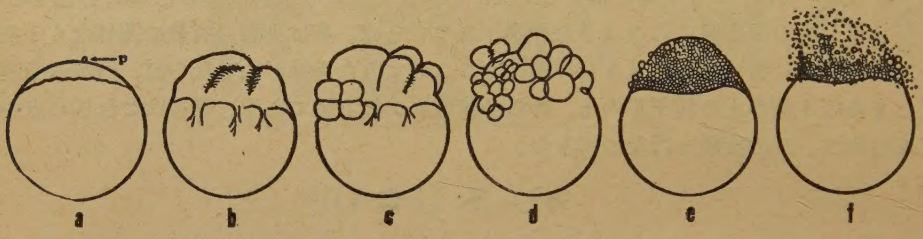

Fig. 2. Development of the egg, fertilized after removal of the membrane (in isotonic Ringer's solution, at about 12° C.).
a : 30 minutes after insemination ; the 2nd polar body (p) was extruded. **b—d** : 3—5 hours after insemination ; egg displayed irregular cleavages characteristic of polyspermy. **e** : 18 hours after insemination ; egg developed into apparently normal blastula but development did not progress far. **f** : 3—4 days after insemination ; egg began to disintegrate.

を始め，30 分後には第 2 極体を放出，2 時間～3 時間後には卵割を始めた。しかし卵割は非常に不規則であり，第 1 回目の卵割で 3 つ以上の割球を生ずるようなものばかりであつた。これらの卵は胞胚期まで進んだが，それ以上は進まず 3～4 日後には細胞崩壊を起してしまつた（以上 Figs. 2～3 参照）。現在までに調べた総数 118 個の卵について云うと，嚢胚にならずに胞胚期で死んだものが 98 個で全体の約 85 %，胚楯形成期まで進んだが完全な胚体を形成するに至らなかつたものが約 10 %，外見上正常と思われる胚（心臓膊動期まで飼育を続けた）になつたものは，わずかに 3 % であつた。その他媒精に全く反応しなかつたものが約 2 %あつた。

このように，裸卵の大部分は異常な発生をするが，これは 1 つの卵に多数の精子が入る，即ち多精現象が起るためであることがわかつた。媒精後 5 分～15 分目の卵数個を ROMEIS 氏液で固定し，切片として FEULGEN 染色をして調べたところ，卵原形質中に多数の精子が入つていることがわかつた。精子が入つているのは動物極だけでなく，植物極の方にもみられた。媒精後 40～60 分目の卵を同じく固定し染色したところ，1 個の卵の中に数個の雄性前核がみられた。筆者は，これらの前核のうち何個が卵核と融合するか調べていないが，卵が異常な卵割や発生をしたのは多数の精子が入つたためと結論してよいであろう。

以上は卵を完全に裸にして媒精した場合であるが部分的に裸にした場合はどうであろうか。このことを知るため Fig. 4 a のような卵を作り，これに媒精してみた。Fig. 4 b, c, d は媒精後7分，40分，3時間後の卵を示す。このように媒精の結果生じた2つの胚盤のうち，卵膜の内側にできたものは規則的な卵割をしていたが，卵膜の外側にできたものは不規則な（多精的）卵割をしていた。このことは前に述べた完全裸卵の受精と共に，卵膜が如何に多精現象を防ぐ上に重要な仕きをしているかを示しているように思われる。多精現象を防ぐ一義的なものは卵膜中にあつて卵原形質中にないように思われる。

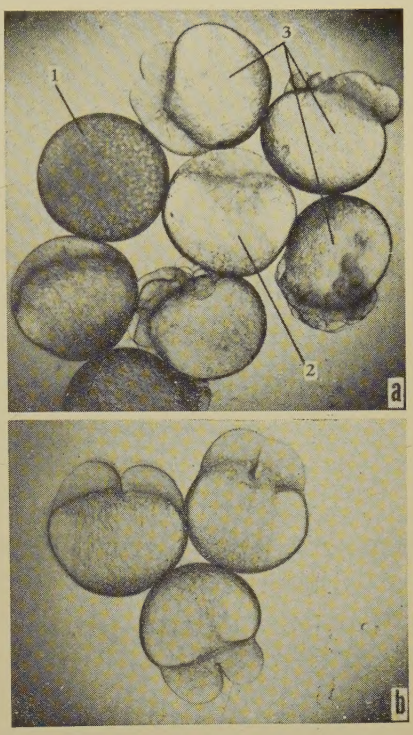

Fig. 3. Photomicrographs of the denuded eggs. × 15. **a** : Eggs which were deprived of their investing membranes and then inseminated; (1) egg just after insemination (2) egg forming blastodisc (3) eggs undergoing irregular cleavage characteristic of polyspermy. **b** : Eggs which were normally fertilized and then deprived of the membranes (control).

なお，媒精時に於ける精子の行動について一言触れたい。前報（柳町 '57 b, c）で述べたように，ニシンの精子は他の多くの海産魚の精子と違つて海水やリンゲル液に触れただけでは殆んど活潑にならず成熟卵の卵門附近に来て始めて活潑になる。この精子を賦活するものは卵門の周りの卵膜にだけあつて卵の原形質中にはない（柳町 '57 d, e）。それで卵膜をもたない裸卵の表面では精子は全く活潑にならない。たとえ，卵表に衝突しても運動を始める徴候を示さない。筆者は，精子がどのようにして卵に入つて行くか，まだよく観察してはいないが，尾を全く振らずに静かに卵原形質中に埋没して行く精子を数例観察した。恐らく精子の頭と卵原形質は元来一種の親和性をもつており，一旦適当な角度で接触すれば，たとえ精子が運動しなくても容易に融合するものと思われる。

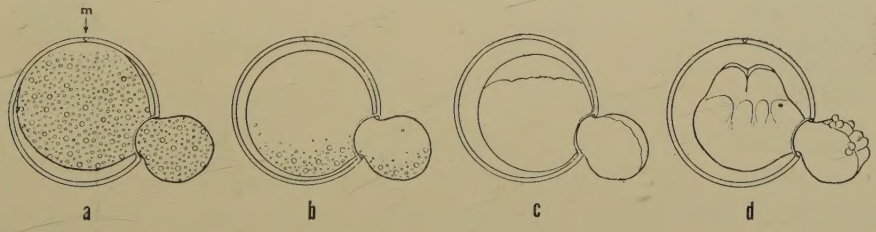

Fig. 4. Egg with a protrusion, before and after fertilization. Membrane of an egg was partially cut off and the egg was pressed in such a way that a protrusion was formed (**a**). When such an egg was inseminated, two blastodiscs were formed (**b—c**). Note that the blastodisc formed in the protrusion showed irregular cleavage characteristic of polyspermy (**d**). *m*, micropyle.

2. 受精卵の場合　正常な条件の下で受精した卵は，その後どんな濃い精子をかけられても受精しない。しかし，前項の実験が暗示するように余分の精子を防ぐ機構が卵膜にあるとすると，卵膜を除いてから精子を加えれば再度の受精が起る筈である。現在のところ，この種の実験を系

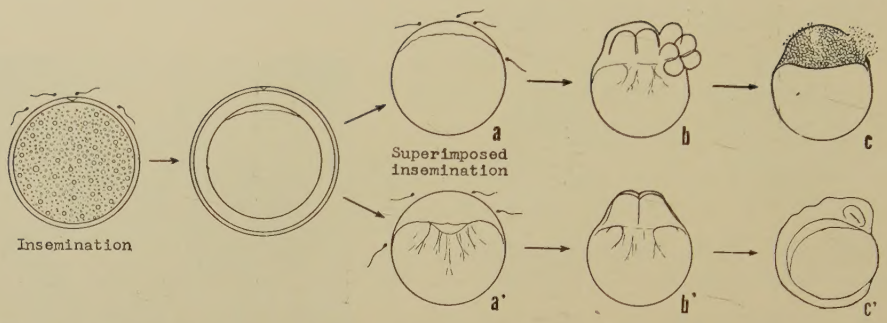

Fig. 5. Effect of superimposed insemination upon the development of the egg.
The eggs which had been normally fertilized were deprived of the membrane and inseminated again. When this procedure was carried out at 10—20 minutes after fertilization, the majority of the eggs, if not all, displayed irregular cleavages characteristic of polyspermy (**a**—**c**). This fact indicates that spermatozoa penetrated into the previously fertilized eggs at the time of superimposed insemination and participated in cleavage. When the superimposed insemination was carried on at about 60 minutes after fertilization, practically all the eggs showed no irregularity in cleavage and produced normal embryos (**a'**—**c'**). This fact may be taken as indicating that the spermatozoa did not enter the eggs at the time of superimposed insemination or even if they entered that they could not take part in the mitotic process of the eggs.

統的には行なつていないが，受精後しばらくの間であれば再受精することがわかつた。Fig. 5a—c は卵を受精後 10—20 分目に裸にして再媒精した場合で，この時には多数の精子が入り卵の発生が異常になつたことを示している。a'—c' は受精後約 1 時間目に再媒精した場合で，この時には殆んど再媒精の影響が現われず卵の大部分が正常な発生をしたことを示している。恐らく，この場合にも精子は入つたのであろうが，卵の原形質が既にかなり変化しているので，彼等はたとえ卵に入つたとしても発生を乱すには至らなかつたものと思われる。

3. 賦活卵の場合 ニシン卵は硝子針による刺傷によつて賦活され，受精されたときのように表層胞の崩壊や胚盤の形成をする（狩野 '53)。Fig. 6 は卵膜を除去せずに媒精，或は除去して

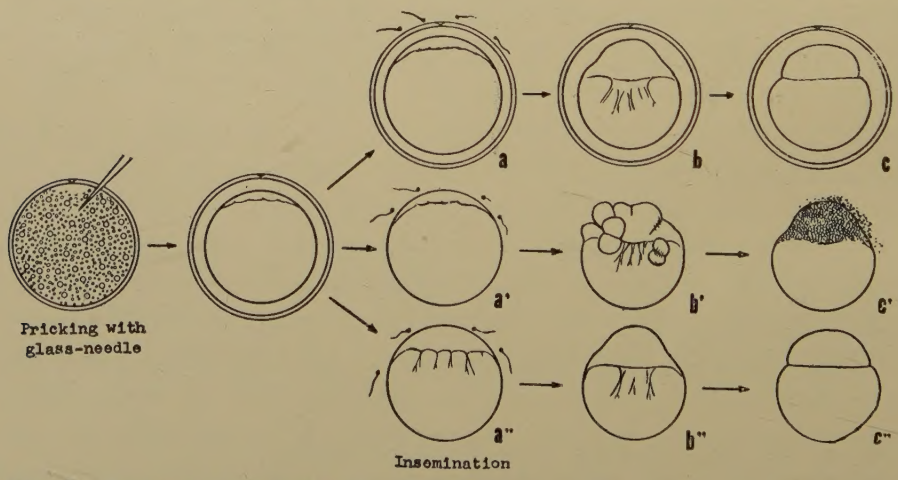

Fig. 6. Response of the artificially activated eggs to insemination.
The eggs which had been activated by pricking were deprived of the membrane and then inseminated. When this procedure was performed at about 10—20 minutes after activation, the majority of the eggs underwent irregular cleavage characteristic of polyspermy and gave rise to more or less irregular blastulae(**a'**—**c'**). However, when the procedure was carried on at about 60 minutes after activation, none of the eggs showed cleavage (**a''**—**c''**). (**a**—**c**) are the control eggs which were inseminated without removal of the membrane ; they never displayed cleavage.

から媒精した場合の結果を示す。a—d は卵膜を除去せずに媒精した場合で，全く卵割しなかつたことを示している。a'—d' は賦活後 10—20 分目に卵膜を除いて媒精した場合で，多数のものが不規則（多精的）な卵割をしながら胞胚期まで進んだことを示している。筆者は賦活卵に精子が実際に入つたか否か切片上で調べなかつたが，卵は刺傷しただけでは卵割することがないので媒精の結果起つた卵割は精子が入つた結果とみてよいであろう。a''—d'' は賦活後約1時間目に卵膜を除去して媒精したもので，この場合には殆んど全部の卵が卵割をしなかつた。恐らく，この場合にも精子は入つたのであろうが，卵原形質が既にかなり変化しているので精子としての仂きをしないで終つたものと思われる。

論　　議

最近，狩野・山本('57)はサケの卵の卵膜を酸性リンゲル液及びパンクレアチンで溶解することに成功している。彼等によると，このようにして得た裸卵もやはり多精現象を起すと云う。この事実は本報で述べた結果と共に，卵膜が多精現象を防ぐのに如何に重要な仂きをしているかを示しているように思われる。云い換えれば，魚卵に於ける単精機構の一義的なものは，卵原形質中にはなくて卵膜にあることを暗示しているように思われる。

では，魚類以外の卵ではどうであろうか。受精の研究の最も行きとどいているウニ卵について云うと，この卵は本報で述べたニシン卵と違い，たとえ卵膜を除去されて裸になつても正常に受精されると云われている（Hultin '48 等）。又一旦受精或は賦活した卵は，特殊な処理をしない限り，たとえ卵膜を除いても再受精しないことが知られている（Loeb '16, p. 85 ; Moore '16, '17 ; Lillie '19, p. 161 and 167 ; 石田・中埜 '47, '50 ; 椙山 '47, '51 等）。これは1個の精子が卵に接触すると同時に，その精子を中心にしてある変化が卵の原形質の表面を伝播し，これが余分の精子の入るのを妨げるためと考えられている。勿論，卵膜にも余分な精子を防ぐ機能があると考えられているが，卵原形質の方にも重要な機構があると云うことに諸家の意見が一致している。

振りかえつてニシン卵の場合をみると，既に述べたように卵膜を除いてしまうと典型的な多精現象を起す。一旦受精或は賦活した卵でさえ，卵膜を除去されると多数の精子を受けいれるようになる。即ち，ウニ卵の場合と違つて，受精後でも卵原形質に余分な精子を防ぐ機構ができ上つていない。できていたとしても局部的なものか，不完全なものか，或はその完成速度の非常に遅いものと云わねばならない。しかし，こゝで注意しなければならないことは，卵の構造がウニとニシンとでは非常に違つていることである。ニシン卵はウニ卵と違い，精子を受けいれる点が卵門と云う一個所に限定されているので，卵門直下の原形質にだけウニ卵に起るような変化が現われゝば，それで余分な精子全部を防ぐに充分と云うことになる。恐らく，1個の精子が卵門を通つて卵原形質に突入すると或る物質が卵原形質から遊離し，これが卵門の下端に或る変化（恐らく閉塞）を与えるのであろう。卵膜はそれ自身，精子に対し不透過であるから卵門に変化が起れば，もはや1個の精子も卵に入れないことになる。卵原形質の全表面を一瞬の中に余分な精子に対し不透過にしてしまうような変化は起らないと考えられる。たとえ起つたとしても，それは卵門直下のごく限られた範囲にだけ起るもので他の部分には伝撒しない，或は伝撒したとしても非常に速度の遅いものと考えられる。

要　　約

ニシン卵は正常な条件の下では1個の精子しか受けいれない。しかし，卵膜を除去してから媒

精すると多数の精子が入るようになる。一旦受精或は賦活した卵でさえ，卵膜を除去されると多数の精子を受けいれるようになる。これらの事実は卵膜が余分な精子の進入を防ぐ上に非常に重要な役割を演じていることを示しているように思われる。

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Résumé

1) The fertilization of the *Clupea* egg is monospermic under normal conditions. It has been found that if the unfertilized egg is deprived of its membrane (cf. Fig. 1) and then inseminated, numerous spermatozoa penetrate into the egg and take part in the mitotic process of the egg. The cleavage and ensuing development of such an egg is therefore almost invariably abnormal (cf. Figs. 2 and 3).

2) The egg, once fertilized, cannot be fertilized again. However, if the membrane of the fertilized egg is removed, the egg becomes refertilizable. Spermatozoa penetrate into the previously fertilized egg and participate in the formation of the mitotic figures producing irregular cleavages characteristic of polyspermy (cf. Fig. 5).

3) The artificially activated egg is incapable of fertilization under normal conditions. It has been shown that if the membrane of the egg is removed, the egg can be fertilized. Spermatozoa enter and cleavage takes place similar to that characteristic of polyspermy (cf. Fig. 6).

4) In view of these findings it seems justifiable to consider that the egg-membrane prevents entrance of supernumerary spermatozoa and constitutes the pricipal mechanism for prevention of polyspermy.

The Digestive Tube of an Omnivorous Cyprinoid Fish, *Barbus stigma* (Cuv. & Val.)*

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The present study is a continuation of the author's previous reports (Kapoor, '53 and in press) and has been conducted to increase the store of information on the digestive tube of teleosts. Contributions by Al-hussaini ('49, '53) and Girgis ('52) have been relied upon heavily for information on this topic. Weinreb and Bilstad ('55) have described the histology of the digestive tract, the liver and pancreas, and the detailed relationship of the swim bladder and its duct to the oesophagus in rainbow trout, *Salmo gairdneri irideus*. A study was also made to determine the sites of phagocytosis.

Several specimens of *Barbus stigma* were dissected to examine the gross anatomy. For histology, live fishes were dissected and the digestive tube in each case was immediately fixed in Bouin's fluid. Sections of the selected regions of the digestive tube were cut at 6 and 8 μ. Delafield's haematoxylin and eosin, Mallory's triple stain and mucicarmine were used for staining the sections.

I owe my warmest thanks to Professor Dr. M.L. Bhatia, Department of Zoology, University of Delhi, whose unfailing interest and sterling assistance, during all the phases of work, have been of inestimable value. Grateful acknowledgement is made to Fisheries Development Adviser to the Government of India, for the kind permission to publish the observations. The work was done while I was in receipt of a Research Training Scholarship granted by the Ministry of Education, Government of India, which is thankfully recognized.

Gross anatomy : *Barbus stigma*, a column feeder, has a small gape of mouth and the lips are absent. Both the jaws are of equal size. Within the buccal cavity are present the maxillary valve (Kapoor, '57) and the small rudimentary tongue (Fig. 1). The pharynx is divided into an anterior respiratory and gustatory part and a posterior into a masticatory one. The pharyngeal teeth are present in three rows in order of 2, 3, 5/5, 3, 2. They are homodont, polyphyodont and are of crushing type (Figs. 2, 3), and strike against the dorsal callous pad (Kapoor, '57).

The oesophagus is the region of gut from the pharyngeal masticatory apparatus to the pyloric sphincter at the commencement of the intestinal bulb. The intestinal bulb is like that in *Catla catla* and its wall is very thin through which the internal folds are visible. The bile duct opens into anterior part of the bulb. The liver lobes cover the intestinal bulb and the gall bladder lies in juxtaposition to the anterior portion of the bulb. The coils of intestine which are few and less complicated surround the bulb. The rectum is not distinguishable (Fig. 4).

* *Barbus stigma* (Cuv. & Val.) or *Barbus* (*Puntius*) *sophore* (Ham.).

The folds of the different parts of the digestive tube are a little different from those of *Catla catla*. The buccal lining is disposed into mild folds. The floor near the tongue has folds in the form of papillae while the pharynx has thick longitudinal folds (Fig. 1). The folds of the oesophagus are longitudinal and those of the intestinal bulb as well as those of the intestine are in a zig-zag fashion and their complexity varies from one part to another (Figs. 5—10). The relative length of the gut is approximately 2.1.

Microscopic anatomy : *Buccal cavity* : The wall of the buccal cavity is composed of mucosa and submucosa (Fig. 11). The mucosa is of stratified nature with mucous cells and taste buds in it. The epithelial cells are of polygonal, fusiform and columnar types and between columnar cells lie the dome-shaped cells which are clearly distinguishable from the other epithelial cells. Mucous cells are limited to the border, vary in size and are of pyriform type. Taste bud consists of the usual neuroepithelial cells and the interposed supporting cells. The mucosa is supported by the basement membrane as well as by the stratum compactum. Underlying the mucosa is the submucosa of connective tissue fibres infiltrated with adipose tissue. Blood capillaries are present in the submucosa.

Pharynx : The pharyngeal wall consists of mucosa (epithelium, basement membrane and stratum compactum), submucosa and muscularis (Fig. 12). The epithelium is stratified and has the polygonal, elongated, columnar, mucous cells and the taste buds. The taste buds are present in the form of small clusters of cells.

The basement membrane and stratum compactum are also observed. The submucosa is made up of fibrous connective tissue and is heavily impregnated with adipose cells. The muscularis is embedded in submucosa and is of striated type. There are no definite circular and longitudinal layers of muscles. Blood capillaries extend up to the basement membrane. The structure of pharynx is similar to that of *Cirrhina mrigala* (ISLAM, '51).

Oesophagus : The oesophageal coats are : mucosa, submucosa, muscularis, and adventitia or serosa (Figs. 13, 14). The mucosa is composed of ordinary epithelial cells and has mucous cells and taste buds in it. The epithelial cells at places are squeezed in between the mucous cells which form a common element in the mucosa. The taste buds are present in abundance. The basement membrane is thin and separates mucosa from the submucosa. The tunica propria is histologically similar to submucosa.

The submucosa is a poorly developed layer and consists of very loosely arranged connective tissue fibres, scattered among which lie numerous longitudinal muscle bundles.

The muscularis is of striated variety and consists of a well-developed circular coat of muscles ; the longitudinal muscle layer forming a distinct outer coat being absent here. Numerous longitudinal muscle fibres, as mentioned earlier, are, however, present in the meshes of submucosa. The serosa is a very thin layer.

A notable feature of the oesophagus is the presence of taste buds in greater number than that in *Wallago attu* (KAPOOR, '53), *Cirrhina mrigala* (ISLAM, '51) and *Cyprinus carpio communis* (CURRY, '39). PICTET ('09) gave the impression that taste buds are numerous throughout the oesophagus.

Intestinal bulb : The intestinal bulb consists of the following tunics : mucosa (epithelium, tunica propria), submucosa, muscularis and serosa (Figs. 15—17). The epithelium of the bulbar mucosa is simple columnar ; the cells are very slender and tall and their nuclei are located in the centre or in the basal third of the cells. There is, however, some difference in the height of columnar cells which are lined by a top-plate. The mucous cells are sparsely present. Nowhere in the intestinal bulb the mucous cells are so plentiful as in the mouth, pharynx and the oesophagus. The part of each mucous cell filled with mucus is typically spherical ; the basal part is long, filamentous and has the oval nucleus. Small wandering cells are quite common in the epithelium. No multicellular glands of the gastric or intestinal types are found in the bulb.

In every fold the tunica propria is a thin sheet of very vascular fibrous connective tissue. In general it may be said that the submucosa does not form a thick layer in the bulb. The muscularis consists of an inner circular and the outer longitudinal layer of muscles. The circular layer of muscles is nearly equal or slightly thicker than the longitudinal muscle layer. The muscle fibres are smooth ; and the connective tissue between the muscle layers is usually small. Serosa is thin and is backed by the connective tissue.

The oeso-intestinal bulb region shows the mixed epithelia and also the pyloric valve (Figs. 18, 19).

PICTET ('09) gave a chain of evidences to show that the intestinal bulb is an enlargement of the anterior part of intestine.

Intestine : The four coats of intestine are mucosa, submucosa, muscularis and serosa (Figs. 20, 21). The epithelial lining consists of three common types of cells : the ordinary columnar, the mucous and the wandering cells. Each columnar cell is long and slender ; the nucleus is large, oval or slightly round and is situated in the central or basal portion of the cell. There is a top plate at the border of the columnar epithelial cells. The mucous cells are numerous and are modified epithelial cells of variable size. They are profusely present near the anal opening. Wandering cells occur between the true epithelial elements and are more common within the fluid-filled intercellular space around the bases of columnar cells and may migrate to the free border. There is no trace of intestinal glands, and there is neither the stratum compactum nor stratum granulosum as mentioned by GREENE ('12) in the intestine of salmon and by MAHADEVAN ('50) in the intestine of *Caranx djedaba*.

The tunica propria, an extension of the submucosa, runs into the folds throughout. The submucosa is a thin stratum of the connective tissue fibres within which run blood capillaries.

The muscularis consists of an inner circular and an outer longitudinal layer of muscles. Muscle fibres are smooth and are bound together by strands of connective tissue. The serosa is a thin outer covering.

At the anal aperture the columnar epithelium of the intestine changes over to the stratified epithelium of the skin.

Summary : Points of anatomical and histological interest are : (1) The digestive

tube of *Barbus stigma* closely resembles to that of *Catla catla*. (2) The buccal cavity contains the maxillary valve and the rudimentary tongue ; the anterior pharynx is respiratory and gustatory and the posterior is masticatory in function ; the oesophagus opens directly into the intestinal bulb ; a sphincter marks the boundary between the oesophagus and intestinal bulb ; the intestine is not very much coiled and the rectum is not differentiated. (3) The buccal epithelium is characterised by the polygonal, fusiform and columnar cells. The basement membrane and stratum compactum are present. (4) The pharyngeal epithelium is packed with mucous cells and taste buds and is supported by a basement membrane and stratum compactum. The adipose tissue and striated muscle fibres in the submucosa are prominent. (5) The oesophageal lining is composed of differentiated stratified epithelium and abundant taste buds and mucous cells. The longitudinal muscle bundles are dispersed in the submucosa. The circular layer of striated muscles forms a thick coat. (6) The oeso-intestinal bulb region shows mixed epithelia. (7) The carp does not have a stomach as is shown by the absence of gastric glands and the point of entrance of the choledochal duct in the intestinal bulb. The structure of intestinal bulb is similar to that of intestine. At the anus the columnar epithelium of the intestine changes over to the stratified epithelium of the skin. (8) The multicellular glands are absent throughout the digestive tube.

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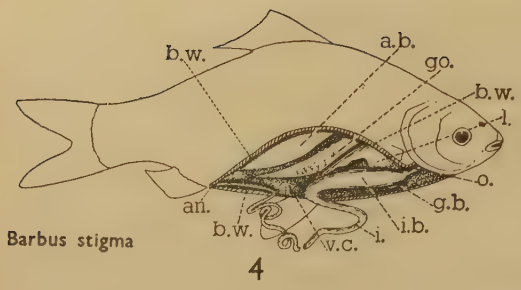

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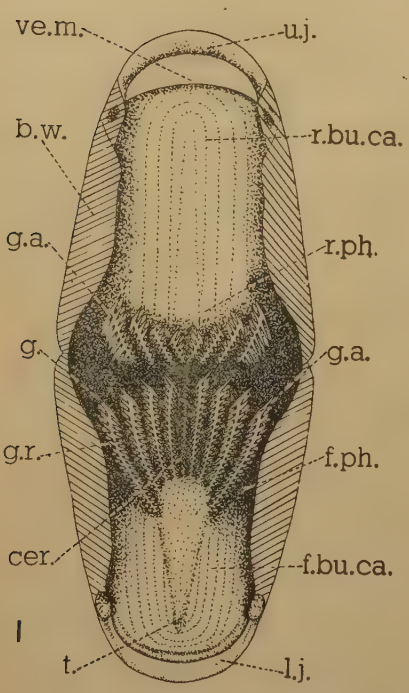

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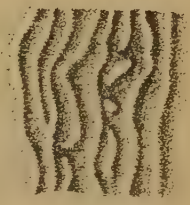

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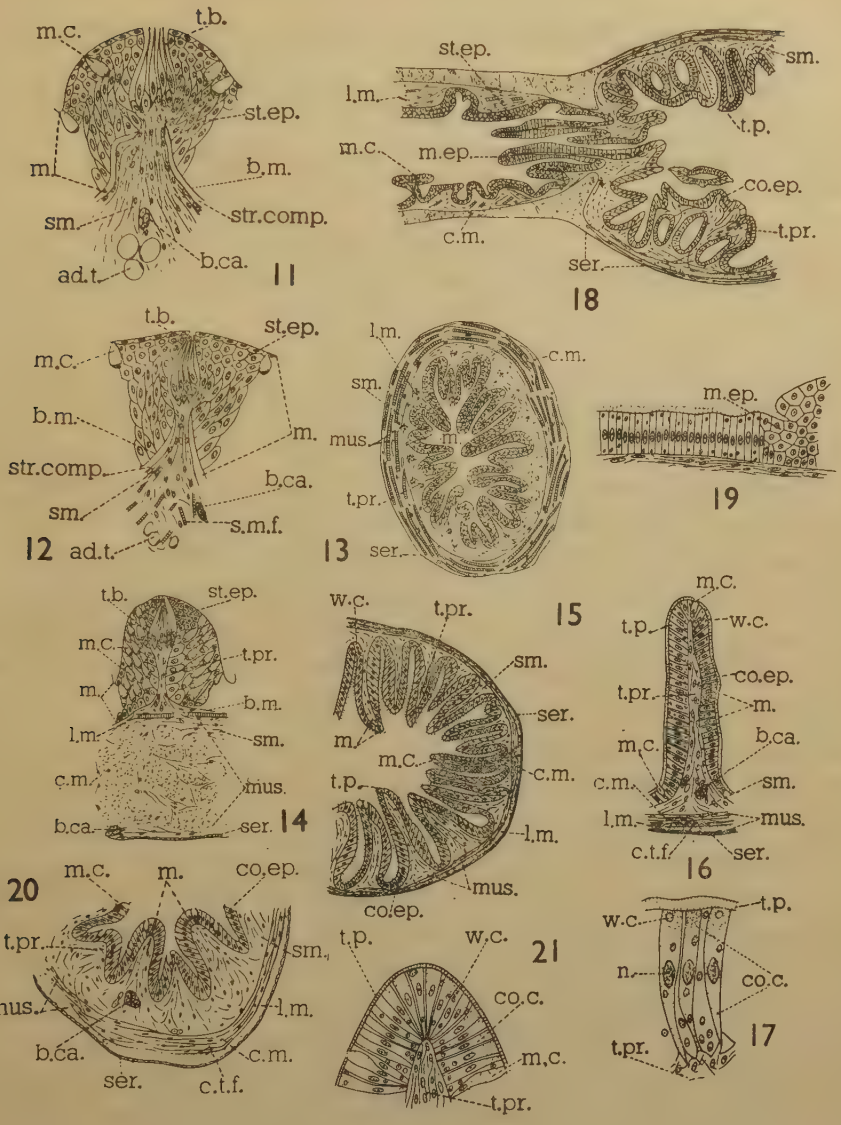
Explanation of figures :

—**Fig. 1**—Buccal cavity and pharynx. **Fig. 2**—Fully developed pharyngeal tooth. **Fig. 3**—Developing tooth. **Fig. 4**—Digestive tube with uncoiled intestine. **Figs. 5–10**—Mucosal folds. (5) Oesophagus, (6) intestinal bulb, (7) anterior part of the intestine, (8) middle part of the intestine, (9) posterior part of the intestine, (10) last part of the intestine. **Fig. 11**—T. S. Buccal wall. **Fig. 12**—T. S. Pharyngeal wall. **Fig. 13**—T. S. Oesophagus. **Fig. 14**—L. S. Oesophagus (magnified). **Fig. 15**—T. S. Intestinal bulb. **Fig. 16**—T. S. Intestinal bulb. **Fig. 17**—Mucosa of the intestinal bulb (magnified). **Fig. 18**—L. S. Oeso-intestinal bulb region. **Fig. 19**—Mixed epithelia in the oeso-intestinal bulb region (magnified). **Fig. 20**—T. S. Intestine. **Fig. 21**—Mucosa of intestine (magnified).



Key to lettering : *a.b.*, air bladder ; *ad.t.*, adipose tissue ; *an.*, anus ; *b.ca.*, blood capillary ; *b.m.*, basement membrane ; *b.w.*, body wall ; *c.m.*, circular layer of muscles ; *c.t.f.*, connective tissue fibres ; *cer.*, ceratobranchial (5th) ; *co.c.*, columnar cell ; *co. ep.* columnar epithelium ; *f.bu.ca.*, floor of the buccal cavity ; *f.ph.*, floor of the pharynx ; *g.*, gill filaments ; g.a. gill arch; *g.b.*, gall bladder ; *g.r.*, gill raker ; *go.*, gonad ; *i.*, intestne ; *i.b.*, intestinal bulb ; *l.*, liver ; *l.j.*, lower jaw ; *l.m.*, longitudinal layer of muscles ; *m.*, mucosa ; *m.c.*, mucous cell ; *m.ep.*, mixed epithelia ; *mus.*, muscularis ; *n.*, nucleus ; *o.*, oesophagus ; *r.bu.ca.*, roof of the buccal cavity ; *r.ph.*, roof of the pharynx ; *s.m.f.*, striated muscle fibres ; *ser.*, serosa ; *sm.*, submucosa ; *st.ep.*, stratified epithelium ; *str. comp.*, stratum compactum ; *t.*, tongue ; *t.b.*, taste bud ; *t.p.*, top-plate ; *t.pr.*, tunica propria ; *u.j.*, upper jaw ; *v.c.*, visceral cavity ; *ve.m.*, velar membrane (maxillary oral valve) ; *w.c.*, wandering cell.

Some Experiments on the Chemical Changes in the Membrane of Salmon Eggs Occurring at the Time of Activation[1)]

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I

In recent years, investigations on the physiology of fertilization in fish eggs have made clear the changes of the egg cortex occurring one after the other at the time of fertilization. According to the studies made by T. YAMAMOTO in *Oryzias*-egg[2)], the cortical alveoli embedded in the cortical protoplasm of the unfertilized egg break down at the time of fertilization and the membrane is elevated from the egg proper by a colloidal osmotic pressure of the perivitelline fluid which is derived from the content of the cortical alveoli.

Although some changes of the membrane in fish eggs at the time of activation have long been known, only a little information is available on the cause of this change. When the egg of salmon is activated by immersion in tap water (KANOH '50), its membrane becomes quite opaque and increases in elasticity. AOKI ('41), comparing the behavior in acid of the membrane of unactivated salmon egg with that of activated egg, found that particular change of solubility had occurred at the time of activation. KUSA ('49 a, b) pointed out the importance of Ca ions in this change.

In the sea urchin egg, the change of the vitelline membrane of unfertilized eggs occurring at the time of fertilization has been studied by many authors (RUNNSTRÖM '52). MOTOMURA ('41, '50) has made clear the important role of the cortical granules extruded from the egg cortex into the perivitelline space in this change of the vitelline membrane. According to him, the cortical granular substance adheres to the inner surface of the vitelline membrane in the presence of Ca ions and the so-called MOTOMURA's third factor. In this way, the vitelline membrane is transformed into the tough fertilization membrane. Judging from the similarity of behavior of the cortical alveoli in fish eggs in the process of fertilization, there is a possibility that the cortical alveolar substance is related to the change of the membrane of fish egg as in the case of the sea urchin egg.

The present paper deals with some information on the chemical changes of the egg membrane occurring at the time of activation in the salmon egg.

II

1) Contribution No. 400 from the Zoological Institute, Faculty of Science, Hokkaido University, Sapporo, Japan.

2) For a review of the problems concerning the physiology of fertilization in fish eggs, see T. YAMAMOTO ('56).

Eggs of dog salmon, *Oncorhynchus keta*, were used as materials. As has been reported by KANOH ('50) and K. YAMAMOTO ('51), the unfertilized and the fertilized eggs of salmon remain unchanged in RINGER's solution[3] but are activated and begin to develop when they are immersed in tap water. The activation of the eggs used here was obtained by immersion in tap water for 30 minutes without insemination. To isolate the membrane from the egg proper, the eggs immersed in RINGER's solution were dissected with scissors. The membrane thus obtained was repeatedly washed with RINGER's solution, and then used for experiments.

Studies were made on the solubility of the membrane of activated eggs in antiformin and the effectiveness of double treatment with acidulated RINGER's solution and pancreatin for the removal of the membrane. The double treatment was performed in the following manner : the eggs were treated, in the first place, with acidulated RINGER's solution (with HCl, pH 1.8) for 15 minutes and then transferred into 0.2 % pancreatin dissolved in RINGER's solution (pH 11.0). As reported in a previous paper (cf. KANOH and YAMAMOTO '57), the membrane of unactivated eggs of salmon is dissolved by this double treatment. All the experiments were performed at room temperature (12°—18°C).

III

As has been stated already, the membrane of activated eggs differs considerably from that of unactivated eggs in its optical and mechanical natures. Specifically, the former is more opaque and more elastic than the latter. As reported in the previous paper (KANOH and YAMAMOTO '57), the membrane of unactivated eggs is dissolved by the double treatment with acidulated RINGER's solution and pancreatin. However, the membrane of activated eggs is not dissolved by this double treatment. It is dissolved only in antiformin with concentrations from 100 to 5 % but in these cases the eggs undergo cytolysis. These facts apparently indicate, therefore, that the chemical nature of the membrane is considerably changed at the time of activation. Similar results have been obtained by AOKI ('41), who studied the behavior of the egg membrane in acid solution. According to him, the acid-soluble property of the inner layer of the membrane isolated from the unactivated eggs is lost as a result of the activation of the egg. Recently, NAKANO ('56) observed the hardening in the membrane of *Oryzias*-egg at the time of fertilization and pointed out that the hardening proceeds parallel with the breakdown of the cortical alveoli.

IV

What is the cause of the solubility change of the membrane occurring at the time of activation? When the membrane isolated from the unactivated egg was immersed in tap water for 30 minutes and was subjected to the double treatment, it was dissolved as in the intact unactivated eggs. Thus it is evident that the change of membrane is induced by the substance extruded from the egg proper at the time of activation. According to KANOH ('50, '54, '56), the cortical alveolar content, Ca ions and ammonium ions are extruded

3) RINGER's solution = M/6.5 NaCl 100 parts + M/6.5 KCl 2.8 parts + M/10 CaCl 3.4 parts (pH 7.2).

from the egg proper at the time of activation. In the present study, the membrane was changed within about 5 minutes after the immersion in tap water and became insoluble by the double treatment. Deducing from the observations of many kinds of fish eggs (cf. YAMAMOTO, K. '51, KANOH '52 b, etc.), the breakdown of the cortical alveoli of the salmon egg is expected to be completed within such short range of time as was actually observed. To test the validity of this expectation, a study was made of the nature of the membrane of an egg which had initiated development without the breakdown of the cortical alveoli. As reported by KANOH ('52 a), KUSA ('53) and T. S. YAMAMOTO ('57), the ooplasm of the egg immersed in M/10 $CaCl_2$ solution begins to accumulate at the animal pole and to form the blastodisc without the breakdown of the cortical alveoli. The membrane isolated from the Ca-treated egg was, however, not dissolved by the double treatment. This finding seems to indicate that the insolubility of the membrane of activated egg may be due to Ca ions ; but this conclusion was controverted by the results of the following experiment : Unactivated eggs washed thoroughly with Ca-free RINGER's solution and with M/10 Na_2-oxalate solution are activated by immersion in M/190 Na_2-oxalate solution for 30 minutes. Probably by this procedure, Ca ions adhered to the egg surface and those extruded from the egg proper at the time of activation might have been precipitated with oxalate contained in the environmental medium. The membrane of the egg thus activated was, however, not dissolved by the double treatment. This result seems to indicate, therefore, that Ca ions have no relation with the change of the membrane ; it seems to be inconsistent with the result obtained in Ca-treated eggs. However, the membrane of Ca-treated eggs differs distinctly from that of the eggs activated with tap water. In the eggs of which the cortical alveoli are broken down by immersion in tap water, the opacity of the membrane is considerably increased in comparison with that of unactivated eggs. This holds true in the eggs which are immersed in tap water for 1 or 2 minutes for inducing activation and then returned to the RINGER's solution. On the other hand, in the Ca-treated egg of which the cortical alveoli remain unbroken, the increase of opacity of the membrane is scarcely visible. From these facts, the insolubility found in the membrane of the Ca-treated eggs may differ in its nature from that found in the membrane of the eggs of which the cortical alveoli have already been broken down. The present author ventures to conclude, therefore, that the insolubility of the membrane which occurred at the time of activation may be caused naturally by the substance which is extruded from the egg proper but not by Ca ions, and that Ca ions are able to induce the change of the membrane in some different way. It is known in the case of sea urchin eggs that the cortical granular substance extruded from the egg cortex at the time of fertilization adheres to the inner surface of the vitelline membrane in the presence of Ca ions and the so-called MOTOMURA's third factor ; that substance then forms the tough fertilization membrane of the developing egg (MOTOMURA '50). Considering the similarity of the behavior of the cortical alveoli in fish eggs and of the cortical granules in sea urchin eggs (KUSA '56), it may be thought that Ca ions play some role in the change of the membrane of fish eggs. Though the present results seem to indicate that Ca ions do not play naturally an active role in the solubility change of the membrane, there still remains a pos-

sibility that Ca ions extruded from the egg proper at the time of activation are not completely precipitated with oxalate before inducing the change of the membrane.

V

As stated already, the membrane of activated eggs was dissolved in antiformin but in this case the eggs underwent cytolysis. The present author attempted the removal of the membrane of activated eggs without inducing cytolysis. It has been reported in the eggs of sea urchin (KOPAC '41) and *Oryzias* (NAKANO '56) that the egg membrane is easily attacked by various agents at the transitional period of its elevation but shows a certain resistance prior to or after this period. Thus, in the present study the activation of the eggs was performed in tap water having various pH values. Probably the membrane is subjected to the effect of pH of the environmental medium during its elevation. After 30 minutes' immersion in these solutions, the eggs were subjected to the double treatment. The results of this experiment are presented in Table 1. It is obvious that the membrane of the egg

Table 1. Removal of the membrane of the activated egg by the double treatment. Eggs were activated by the immersion in tap water having various pH values for 30 minutes, then were subjected to the double treatment.

Tap water		Time required for removal of the membrane by the double treatment
pH	Egg-activation	
2.0	−	?
3.0	−	−
4.0	+	−
5.8	+	−
6.8	+	−
7.2	+	−
8.0	+	−
9.5	+	−
10.0	+	−
11.0	+	−*
12.6	+	18 hours

* Egg membrane was attacked considerably.

activated with strongly alkalized tap water is dissolved by the double treatment. In this experiment, the removal of the membrane was not attained without the treatment with acidulated RINGER's solution. The membrane of the egg, immersed in alkalized tap water for 30 minutes after activation had been induced in neutral tap water, was not dissolved by the same treatment. It is clear, therefore, that the removal of the membrane of the activated egg by the double treatment is possible only when the membrane is effected at the transitional period of its elevation.

VI

The results presented in this paper may be summarized as follows : At the time of activation, the chemical nature of the egg membrane is considerably changed by the substance extruded from the egg proper. The content of the cortical alveoli extruded from the egg cortex seems to be related to this change of the membrane. If the activation of the

egg is induced in strongly alkalized tap water, in other words, if the membrane is effected by alkali in the transitional period of its elevation, the membrane of the activated egg is dissolved by the double treatment with acidulated RINGER's solution (with HCl, pH 1.8) and with 0.2% pancreatin dissolved in RINGER's solution (pH 11.0). Probably alkali inhibits the reaction between the membrane and the substance extruded from the egg proper at the time of activation.

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A Study of the Lateral-line System in Fish
I. Quantitative Analysis of Fiber Calibers in the Lateral-line Nerves of Fishes

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INTRODUCTION

The function of the lateral-line organs of fishes has already been studied by many investigators, the early works of whom were done on the behaviour of fishes when the lateral-line organ had been destroyed, and the other works on the electrical response of the lateral-line nerve.

Judging from these previous works, it is known to be mainly one of the mechanoreceptors.

It is assumed that lateral-line organ is of use to fishes in feeding, escaping and schooling, being compensated by the other sense organs.

Since fishes, in general, may be divided into somewhat natural groups according to their habits and morphological variations are found in other sense-organs, it may be considered that there are structural or functional differences in the lateral-line organs of fishes according to their lives.

Now, the lateral-line organ in the side of the fish is innervated by the ramus lateralis of vagus (a pure sensory nerve branch). KATSUKI, YOSHINO and CHEN (1950—52) have already reported that the response of each lateral-line nerve fiber of the eel to various kinds of natural and artificial stimuli was different according to its diameter.

This information is very important to understand the relationships between structure and function of sense organ. It is very interesting morphologically as well as physiologically, to compare the relevant nerves in many kinds of fishes. It might be assumed that each of them has a characteristic in distribution of fibers according to its habit.

We attempted to make a quantitative analysis of fiber calibers in the lateral-line nerves on 81 different species of teleosts, and we found some marked difference among them, and this made it clear that we were able to discuss the problem on correlation of the functions of the sense organs and the habits of the fishes, from the result of this experiment.

Much of the work during the course of this study was carried out at the Marine Biological Station on Misaki in Kanagawa Prefecture. The authors are grateful to Prof. Dr. Y. SUYEHIRO and Ass. Prof. T. HIBIYA of University of Tokyo, and Prof. Dr. Y. KATSUKI of Tokyo Medico-Dental College.

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MATERIAL AND METHOD

The present experiment was done by using 81 different species of teleosts, which represented 50 families, as shown in Table 1. They were adult in all, and most of them were used in state of living.

First, fish was freshly pitched and pinned on a board, and a few cm. of the skin near the operculum was removed backward along the body. As the nerve is buried deep in the muscle, we cut off the ramus lateralis of vagus from the body, after having exposed about 3cm. of it. The nerve, moistened in the physiological salt solution* on a slide, was separated into each component with two needles, by using a binocular magnifer (×30).

The fiber-calibers of above three hundreds fibers were measured in fresh living state with a ocular-screw-micrometer, under a microscope (×150).

RESULTS

As the lateral-line nerve consisted of many myelinated fibers of various calibers, the diameter of each fiber was measured in size including myelin sheath.

As the results of pre-examinations made on the adult fishes of gold fish, catfish and eel, we found no individual variation in distribution of fibers, comparing the mean value and the range in diameter of fibers.

But the distribution of fiber diameters in one species was different from that of another species of fishes, and therefore it shows a characteristics of each species of fish.

The histogram for the fiber diameters had one prominent peak, and the mean value in diameter laid near it.

The results of measurement on 81 species of teleosts were shown in Table 1.

Looking over the whole fishes studied in the present experiment, the following three types might be distinguished in their fiber distribution.

1) The nerve consisted, for the most part, of relatively thin fibers, and most of them had diameter of 4 μ, to 6 μ, a smaller proportion 6 μ—10 μ, and a few 3 μ. No fiber with diameter exceeding 10 μ was observed.

2) The fiber varied from 3 μ to 15 μ in diameter, and the great part of them had diameters of 6 μ to 10 μ.

3) The fibers were thicker than another two types as mentioned above. The mean value in diameter was over 8 μ in all species, and the deviation in caliber was large, as there were found more kinds of fibers in the nerve varying their size.

Thus, it was noticeable that there were these three types on all fishes, both in marine and in fresh water.

Considering the properties above-mentioned, we could divide these 81 species into three groups.

Group I. In *Carassius auratus*, *Plotosus anguillicaudatus*, *Chasmichthys dolich-*

* By YAMAMOTO (1949), for fresh water fish, NaCl 0.75 %, KCl 0.02 %, $CaCl_2$ 0.02 %, $NaHCO_3$ 0.002 % ; for marine fish, NaCl 1.35 %, KCl 0.06 %, $CaCl_2$ 0.025 %, $MgCl_2$ 0.035 %, $NaHCO_3$ 0.002 %.

ognatus gulosus, *Acheilognathus moriokae*, and *Sebastiscus marmoratus*, about 70 per cent of the nerve fibers had diameters of 3 μ—5 μ, and 30 per cent of diameters of 6 μ—10 μ [Table 1 (I—a)]. On the contrary, the ratio of fibers between 3 μ and 5 μ to fibers between 6 μ and 10 μ in diameter was 40 to 60 per cent in *Cathigaster rivulatus*, *Pseudolabrus japonicus*, *Oryzias latipes*, and *Pseudorabora parva* (I—b).

Group II. Of the nerve fibers, about 78 per cent had diameter of 6 μ—10 μ, 20 per cent diameters of 3 μ—5 μ, and 2 percent diameters of 11 μ—15 μ. For example,——— *Cyprinus carpio* and other 12 species (II—a).

Of the nerve fibers, about 85 per cent had diameters of 6 μ—10 μ, 7.5 per cent diameters of 3 μ—5 μ, and 7.5 per cent diameters of 11 μ—15 μ. For example——— *Scomber japonicus* and other 14 species (II—b).

Of the nerve fibers, about 74 per cent had diameters of 6 μ—10 μ, 24 per cent diameters of 11 μ—15 μ, and 2 per cent diameters of 3 μ—5 μ. For example———*Mugil cephalus*, and other 8 species (II—c).

No fiber with diameters under 5 μ was observed and the number of the fibers diameters of 6 μ—10 μ was nearly equal to that of 11 μ—15 μ, in *Salvelinus fontinalis fontinalis*, *Channa argus*, *Hippoglossides debius*, *Lepidotrigla microptera*, and *Chromis notatus*. However, in *Misgurunus anguillicaudatus*, 95 per cent had diameters of 6 μ—10 μ (II—d).

Group III. In *Oncorhyncus keta*, *Anguilla japonica*, *Conger japonicus* the nerve consisted of fibers ranging in size from 4 μ to 16 μ. About 60 per cent of them had diameters of 6 μ—10 μ, and 30 per cent had diameters of 11 μ—15 μ. The similar tendency was observed in other 18 species (III—a).

No fiber with diameters under 5 μ was observed, and the number of the fibers with diameter of 6 μ—10 μ was nearly equal to that of 11 μ—15 μ and that of 16 μ—20 μ was very small in *Cymrothorax kidako*, *Girella punctata*, *Chelidonichthys kumu*, *Hoplobriotula armata*, and *Paralichthys olibaceus*. Besides, there were also found the fibers over 20 μ in diameter, and the mean value of fiber diameters was large in *Cololabis saira*, *Hemiramphus sajori*, and *Prognichtys agoo* (III—b).

SUMMARY AND CONCLUSION

1. The quantitative analysis of fiber calibers in the lateral-line nerve of fish was done on 81 different species of teleosts.

2. The lateral-line nerve of the fish consisted of many kinds of fibers which differed in diameter, but the individual variation of fiber distribution was not found in the same species. Therefore, it is possible to compare the natures of the fiber in many species of fishes by measuring fiber calibers.

3. There were found three main types in fiber distribution of the relevant nerve in all fishes examined in the work. From this result, we attempted to divide the fishes into some groups according to the fiber distribution. But, there were found several subgroups in one group, and one form of fiber distribution gradually changed to that of another group

through these subgroups. From this fact, it appears that there are the differentiation in nerve fibers of the lateral-line nerve.

4. It may be remarked that the method of measuring fiber-calibers used in this experiment is more suitable to compare the lateral-line nerve in many species of fishes than that of measuring fixed fiber because anxiety of shrinking or swelling was eliminated by using unfixed and living fiber.

5. In the next report, we will discuss on the relation between the function of the lateral-line organ and the habits of fish from the ecological stand point of view.

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Table 1. Fiber diameter in the lateral-line nerve of fish.

Family	Species	$\bar{x}$ (μ)	σ (μ)	Group
Clupeidae	*Clupea pallasi* Cuvier et Valenciennes	8.6	1.9	II c
	Harengula zunasi (Bleeker)	6.5	1.6	II a
Engraulidae	*Engraulis japonica* (Houttuyn)	6.0	1.6	II a
Salmonidae	*Oncorhynchus keta* (Walbaum)	9.6	2.5	III a
	Salmo gairdnerii irideus Gibbons	8.9	2.1	II c
	Salvelinus fontinalis fontinalis (Mitchill)	9.4	2.1	II d
Plecoglossidae	*Plecoglossus altivelis* Temminck et Schlegel	9.1	2.3	II c
Cyprinidae	*Acheilognathus moriokae* Jordan et Thompson	5.0	1.4	I a
	Hemibarbus barbus (Temminck et Schlegel)	8.7	1.9	II c
	Pseudorasbora parva (Temminck et Schlegel)	5.3	1.2	I b
	Tribolodon hakonensis hakonensis (Günther)	6.8	1.0	II a
	Carassius auratus (Linné)	6.0	1.7	I a
	Cyprinus carpio (Linné)	6.7	2.0	II a
	Misgurnus anguilicaudatus (Cantor)	8.1	1.4	II d
Siluridae	*Parasilurus asotus* Linné	8.8	1.9	II c
Plotosidae	*Plotosus anguillaris* (Lacépède)	5.0	1.5	I a
Anguillidae	*Anguilla japonica* Temminck et Schlegel	8.8	2.4	III a
Congridae	*Conger japonicus* Bleeker	8.7	3.1	III a
	Astroconger myriaster (Brevoort)	9.0	2.2	III a
	Rhynchocymba nystoromi nystormi (Jordan et Snyder)	8.1	2.9	III a
Muraenidae	*Gymnothorax kidako* (Temminck et Schlegel)	9.3	2.0	III b
Cyprinodontidae	*Oryzias latipes* (Temminck et Schlegel)	5.8	1.2	I b
Scombresocidae	*Cololabis saira* (Brevort)	11.9	2.5	III b
Hemiramphidae	*Hemiramphus sajori* (Temminck et Schlegrl)	13.2	3.4	III b
Exocoetidae	*Prognichtys agoo* (Temminck et Schlegel)	13.5	3.4	III b
Monocentridae	*Monocentris japonicus* (Houttuyn)	6.8	1.7	II a
Atherinidae	*Allanetta bleekeri* (Günther)	8.3	2.5	II c
Mugilidae	*Mugil caphalus* Linné	8.9	1.8	II c
Sphyraenidae	*Sphyraena pinguis* Günther	9.8	2.8	III a
Channidae	*Channa argus* (Cantor)	9.9	1.9	II d
Scombridae	*Scomber japonicus* Houttuyn	7.7	1.8	II b
Carangidae	*Trachurus japonicus* (Temminck et Schlegel)	6.4	1.8	II a
	Seriola purpurasens Temminck et Schlegel	7.1	1.9	II b
Labracoglossidae	*Labracoglossa argentiventris* Peters	8.5	2.7	III a
Mullidae	*Upeneus bensai* (Temminck et Schlegel)	6.4	1.6	II a
Apogonidae	*Apogon semilineatus* Temminck et Schlegel	4.3	1.4	I a
Priacanthidae	*Pseudopriacanthus niphonius* (Cuvier)	7.0	1.5	II b
Pomatomidae	*Scombrops boops* (Houttuyn)	8.7	2.4	III a
Serranidae	*Lateolabrax japonicus* (Cuvier)	7.9	2.3	III a
	Epinephelus septemfasciatus (Thunberg)	7.6	3.0	III a
	Niphon spinosus Cuvier et Valenciennes	7.3	1.8	II b
Sillaginidae	*Sillago sihama* (Forskål)	7.4	1.8	II b
Girellidae	*Girella punctata* Gray	9.3	2.3	III b
Sparidae	*Chrysophrys major* Temminck et Schlegel	7.0	1.7	II b

Pomadasyidae	*Parapristipoma trilineatum* (THUNBERG)	8.7	2.9	III a
	Plectorhynchus cinctus (TEMMINCK et SCHLEGEL)	7.4	1.6	II b
Aplodactylidae	*Goniistius zonatus* (CUVIER et VALENCIENNES)	6.8	2.2	II a
Parapercidae	*Cilias pulchella* (TEMMINCK et SCHLEGEL)	7.5	2.0	II b
Brotulidae	*Hoplobrotula armata* (TEMMINCK et SCHLEGEL)	10.6	2.4	III b
Gobiidae	*Acanthogobius flavimanus* (TEMMINCK et SCHLEGEL)	7.6	1.5	II b
	Pterogobius zonoleucus JORDAN et SNYDER	7.4	1.8	II b
	Chasmichthys gulosus (GUICHENOT)	4.5	1.4	I a
Embiotocidae	*Ditrema temmincki* BLEEKER	7.4	2.0	II b
Pomacentridae	*Chromis notatus* (TEMMINCK et SCHLEGEL)	10.0	1.9	II d
Labridae	*Thalassoma lutescens* (LAY et BENNETT)	7.6	1.6	II b
	Pseudolabrus japonicus (HOUTTUYN)	5.6	1.4	I b
	Halichoeres poecilopterus (TEMMINCK et SCHLEGEL)	8.6	2.5	III a
Acanthuridae	*Prinurus microlepidotus* LACÉPÈDE	8.6	2.1	III a
Aluteridae	*Stephanolepis cirrhifer* (TEMMINCK et SCHLEGEL)	9.6	3.9	III a
	Navodon modestus (GÜNTHER)	7.6	3.2	III a
Tetraodontidae	*Canthigaster rivulatus* (TEMMINCK et SCHLEGEL)	5.0	1.7	I b
	Fugu niphobles (JORDAN et SNYDER)	7.3	1.9	II b
	Fugu vermicularis vermicularis (TEMMINCK et SCHLEGEL)	6.8	1.6	II a
	Fugu pardalis (TEMMINCK et SCHLEGEL)	6.8	1.9	II a
	Fugu chrysops (HILGENDORF)	7.5	1.6	II b
Scorpaenidae	*Sebastes oblongus* GÜNTHER	9.0	2.3	III a
	Sebastiscus marmoratus (CUVIER et VALENCIENNES)	4.4	1.2	I a
	Pterois lunulata TEMMINCK et SCHLEGEL	6.4	1.9	II a
Hexagrammidae	*Hexagrammos otakii* JORDAN et STARKS	8.3	2.3	II c
Platycephalidae	*Suggrundus meerdervoorti* (BLEEKER)	8.6	2.7	III a
	Platycephalus indicus (LINNÉ)	10.1	2.6	III a
Cottidae	*Pseudoblennius percoides* GÜNTHER	6.7	1.5	II a
	Pseudoblennius zonostigma JORDAN et STARKS	6.4	2.3	II a
Triglidae	*Cheliodonichthys kumu* (LESSON et GARNOT)	10.2	2.4	III b
	Lepidotrigla microptera GÜNTHER	9.4	1.9	II d
Bothidae	*Paralichthys olivaceus* (TEMMINCK et SCHLEGEL)	10.6	2.3	III b
Pleuronectidae	*Hippoglossides dubius* (SCHMIDT)	9.1	2.0	II d
	Pleuronichthys cornutus (TEMMINCK et SCHLEGEL)	11.0	2.8	III a
	Kareius bicoloratus (BASILEWSKY)	9.8	2.2	III a
Soleidae	*Zebrias zebra* (BLOCH et SCHNEIDER)	7.7	1.6	II b
Gadidae	*Theragra chalcogramma* (PALLAS)	8.8	2.6	III a

徳島近海に於けるマアジの漁獲状況

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On the fishing condition and size of horse mackerel, *Trachurus japonicus*, taken in the Pacific coast of Tokushima Prefecture

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緒　　言

マアジ（*Trachurus japonicus*）は沿岸漁獲物として重要なもので，本邦のアジ類魚類の陸揚量（ムロアジ・マルアジ等が含まれるが，数量的には全部をマアジと見ても大きな誤はない）を農林統計によつてみると，1930 年～1939 年には 530～850 萬貫のものが，1946 年～1952 年に 586～5,501 萬貫で，近年は 6,000 萬貫前後と急激な増獲を示している（第1表）。この様に本邦ではイワシ・サバと共に重要な魚種となつているが，その生態に就いては，岡部（'39），村上・真道（'49），山田・梶原（'54・'56），矢住（'55），塚原・塩川・本田（'55），畑中（'50），相川・加藤（'38），三田（'57）等により幾分明らかにされてきたが未だ不明の点が多い。

第1表　本邦のアジ類の漁獲量（1000 貫）

年　度	漁　獲　量
1946	585.7
'47	748.4
'48	788.8
'49	1312.1
'50	1928.1
'51	2469.9
'52	5569.9
'53	6376.4
'54	6699.0
'55	6357.0

筆者等は徳島県太平洋岸の日和佐附近のマアジについて，その出現状況や時期的な漁況の変化及びその魚体組成との関係等について調査した結果について報告する。

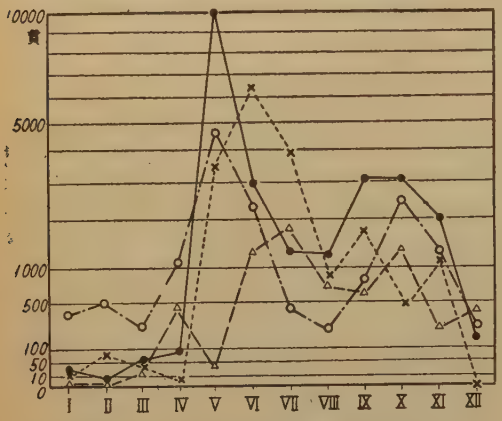
出　現　状　況

徳島県の沿海部は地理的にみて，その立地条件から3つの海区に区分することが出来る。即ち純内海性の播磨灘，純外海性の太平洋岸と両者の中間性の紀伊水道の3海区である。この様な立地（環境）条件の差に伴つて時期的に或は地理的にマアジの洄游状態やその魚体の大きさ等に相違があるかどうかも興味のあるところである。従つて海区別にマアジの漁期・漁

第2表　海区別の漁期・漁具・魚体の相違

海区＼魚体 漁具・漁期	大　型	小　型
播磨灘	桝網（5月）極少量	桝　網（6月～12月） 揚繰網（10月～11月） たたき（5月～12月） 一本釣（5月～11月）
紀伊水道	一本釣（5月～11月）〕南部 巾着網（5月～11月）〕	バッチ網（5月～11月） 角　網（5月～10月） 雑曳網（5月～6月）
太平洋側	一本釣（5月～12月） 延　縄（11月・12月）	八田網（4月～11月） 角　網（4月～11月） 機船底曳網（11月～3月）極少量

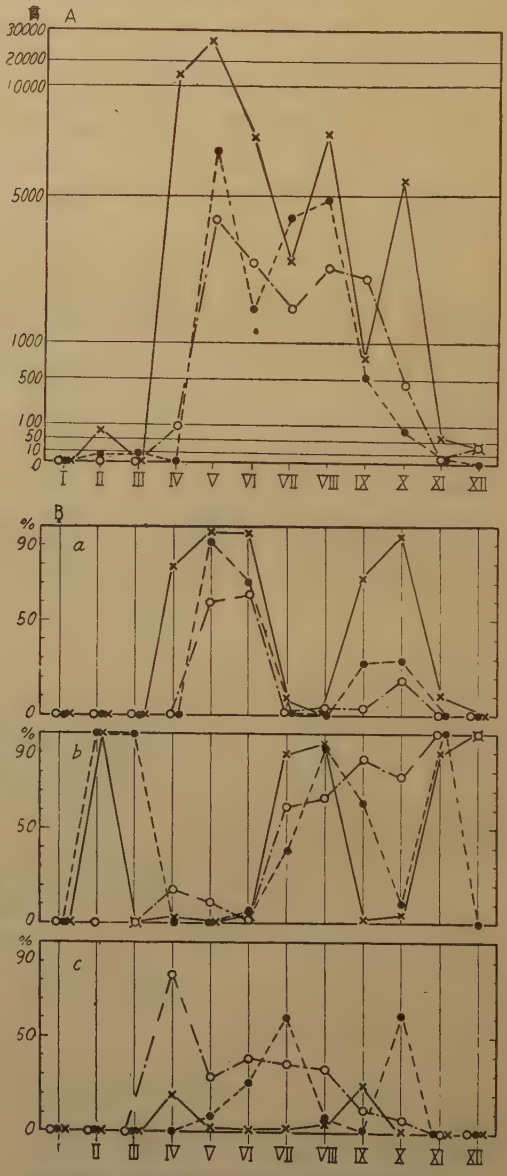
具及び魚体の大きさについて聞取調査の結果を取纏めると第2表の通りである。これを総括的にいうと，マアジの出現状態は南部水域に早く，北部に従つて遅い。魚の大きさでは大型魚は南部水域（太平洋側）・紀伊水道南部に限定され，殆んど紀伊水道北部から瀬戸内海（播磨灘）に洄游するとこはない。之に反して小型魚は各海区に亘つて，相当長期間漁獲される。従つてマアジは魚体の大小によつて環境に対する適応が異る様である。太平洋岸では第2表で判る様に大体周年漁獲があるので，この海区に於ける季節的な漁況の変化やその魚体の大きさの変化等について吟味してみる。即ちこの海区で重要なる漁港となつている日和佐港の 1942 年～1945 年及び 1948 年～1950 年の各年・月別の漁獲量の変動



第1図　徳島県太平洋岸日和佐附近のマアジ陸揚量各年・月別変化

——○——1942　……×……1944
——●——1943　——△——1945

を表わすと第1図及び第2図Aの様である。次に 1948 年～1950 年の各月の魚体の大きさ別* の混獲割合を漁業協同組合の日々の水揚仕切伝票を調べて整理し，之を百分率で表わしたものが第2図Bである。これらのことから徳島県太平洋岸日和佐附近のマアジ漁業で，漁獲の多い時期は春季（4月～6月）と秋季（9月～11月）の2回である。このことは第2図Aをみても同様な傾向が認められる。この2回の漁獲の山の漁獲物は大部分大型魚によつて占められている。夏季（7月・8月）の小型魚・アジ仔もかなりの漁を示しているが，矢張り大型魚の洄游状態（配分量の多寡）はこの附近のマアジの漁況に大きく影響していることが判る。春季のものは生殖巣もよく成熟しており，いわゆる北上産卵群，秋季のものはその南下群と称されるもので，前者の方が重要度は高い。



第2図　日和佐港のマアジの月別陸揚量（A）と魚体の大きさ別混獲率（B）の変化

——○——1948　a：大型アジ
……●……1949　b：小型アジ
——×——1950　c：アジ仔

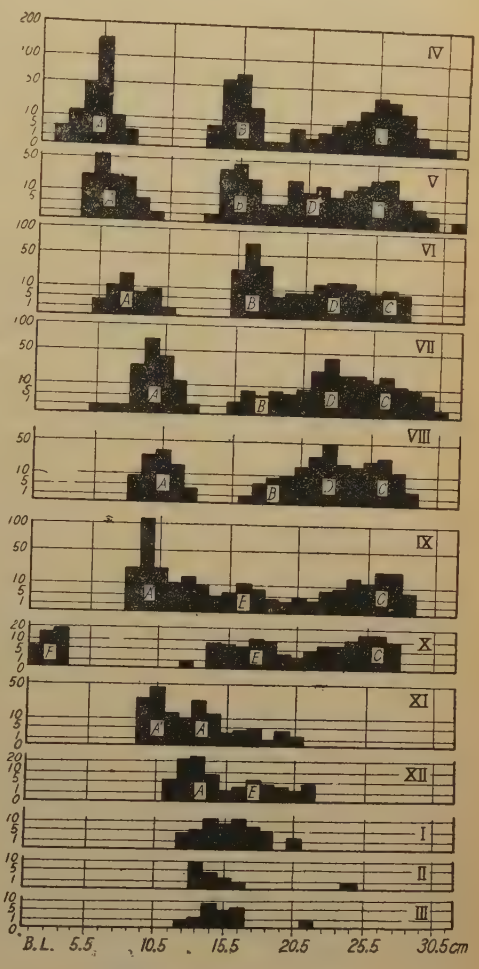
* 魚体の大きさは大型・小型及びアジ仔の3種類に区別され，各々仕切が異なり容易に区別出来る。

アジ仔は4月末より混獲割合が目立つて多くなつてくるが，8月末頃から急激に少なくなり姿を消すが，年によつては秋季に再び小さいピークを形成する。小型魚は夏からアジ仔に代つて沿岸の定置網・敷網類で大漁を呈するが，時には秋季の大型魚に代つて晩秋まで漁獲の大半を占めることがある（第2図B)。近年この小型魚の漁獲が多くなつている。

魚体組成

第3表は漁具別に体長を測定した記録* で，この記録により月毎に体長のヒストグラムを描いたものが第3図である。先ず漁具による魚体の差は，4月～11月の定置網（角網）及敷網(八田網)では体長 15cm 前後の小型魚と体長 5cm 前後の幼魚が漁獲対象で，体長 20cm 以上のものは漁獲されない。一本釣では時期により多少の相違はあるが，大体 20cm 以上のものが対象となつている。従つて前述した魚体の大型・小型及びアジ仔というのは，夫々大体体長 20cm 以上のもの，10～15cm 前後のもの，5cm 前後からそれ以下のものを指している様である。

次に時期的に魚体をみてみると，漁期始めの4月には体長 5.5cm，15.5cm，25.5cm にモードを持つ3つの魚群が漁獲されている（以下これを便宜上A，B，C群と呼ぶ)。5月・6月にはこのA・B・Cの3群の外に 20.5 cm 附近にモードを有する群（D群と呼ぶ）が出現し，このD群は7月・8月にはC群と共に一本釣漁獲物の主要部分を占める。この頃定置網ではA群の成長と考えられる 10.5cm モード群が好漁である。9月に入るとD群は少なく，C群と更にA群より稍小型の 9.5cm 附近にモードを持つ群（A′群）と 16.5cm 附近にモードを持つ群（E群）が現われ，10月にはC・D・E群の外に 3.5cm 附近にモードを有する幼魚群（F群）が出現する。11月以降測定尾数も少ないが，殆んどA群によつて占められるが漁獲量は極く少量である（第2表・第2図A・B)。この頃のA群が翌年4月のB群に連続するものと思われる。



第3図　体長組成の月別変化

この様に日和佐附近のマアジの魚群は時期によつて，或は群によつて魚体の大きさが異なり，その成長傾向が極めて複雑な様相**を呈していることが判る。前述した様に4月のA・B・Cの3群は夫々年令群が異なつているものと思われ

* 体長は吻端から被鱗部末部迄を測定した，表中同一測定日でも調査対象船が異なつた場合又は体長組成が双峯分布を明らかに示す場合は区別して取扱つた。

** この点につき種々御討議御指導いただいた東大教授大島泰雄博士に厚くお礼申し上げる。

第3表　漁具別マアジの魚体測定記録

A……1本釣　B……定置網　C……敷網　D……機船底曳網
E……パツチ網　F……地曳網

採集年月日		体長 (cm) 範囲	平均	測定尾数	漁具
'51	6	12.4～22.6	15.8	30	D
〃 Jan.	22	12.9～13.9	13.2	3	A
〃	26	14.0～18.0	15.9	26	D
〃 Feb.	4	13.0～16.6	14.1	16	D
		24.0	—	1	
〃	4	21.2	—	1	D
		16.5	—	1	
〃 Mar.	12	12.9～15.0	14.0	10	A
〃	29	14.8～16.8	15.8	11	D
〃	5	14.0～16.2	14.7	51	A
〃	8	2.6～ 4.5	3.8	18	F
〃	9	3.1～ 4.0	3.6	4	E
〃	10	6.4～ 7.2	6.8	2	C
		13.3～15.5	14.3	10	A
〃	14	13.0～16.4	15.2	10	A
		23.5～26.5	25.4	13	
〃	15	15.2～16.2	15.6	6	A
〃	18	13.9～17.0	15.4	35	A
Apr.		14.0～16.3	15.7	25	C
〃	23	21.3～25.3	23.3	15	A
		27.0～30.0	27.9	5	
'49	24	2.6～ 4.2	3.6	3	F
'51	25	14.8～21.0	16.1	33	A
〃	27	14.2～16.3	15.0	10	A
〃	28	19.5～28.6	24.8	71	A
〃	29	4.0～ 7.3	5.4	216	C
		23.0～29.7	25.4	39	A
〃	30	20.5～28.2	24.8	19	A
〃	2	13.8～16.2	14.8	15	A
〃	3	5.5～ 5.8	5.6	2	A
		14.1～16.6	15.5	42	
〃	6	3.6～ 6.9	5.2	23	C
'50	7	21.5～28.7	24.6	46	A
'51	7	14.3～16.5	15.4	10	A
'50	12	5.1～ 7.5	6.1	24	C
		24.7～25.2	24.9	4	A
〃	13	17.9～22.3	19.8	23	A
〃 May	14	17.0～22.2	19.9	16	A
		25.0	—	1	
〃	15	22.4～31.0	25.9	38	A
'51	15	4.6～ 6.3	5.2	50	C
'50	16	17.7～25.6	21.6	20	A
'51	17	15.5～17.3	16.1	10	A
'50	20	14.0～15.0	14.5	10	A
〃	25	6.0～ 8.5	6.6	28	A
		14.5～28.0	20.8	65	
〃	28	7.1～ 9.7	7.7	9	C
〃	4	15.8～19.6	17.3	23	A
		22.0～28.0	23.4	15	
〃 June	5	5.5～ 8.0	7.0	38	C
〃	5	19.2～28.5	23.9	49	A
		16.3～20.0	17.1	21	

採集年月日		体長 (cm) 範囲	平均	測定尾数	漁具
'50	11	16.5～21.2	19.5	5	A
〃	13	7.6～10.0	9.0	15	C
〃	16	15.3～17.7	16.6	45	A
〃 June	19	15.4～18.2	16.3	30	A
		20.5～28.4	27.5	31	
〃	26	15.0～17.2	16.1	27	A
		23.0～27.5	26.2	16	
〃	3	19.0～27.0	21.1	16	A
〃	12	5.9～ 6.8	6.3	2	B
'53	13	16.0～24.3	20.6	70	A
		24.0～30.0	26.7	33	
July		8.0～12.0	9.3	94	
'50	16	9.0～11.2	9.9	18	A
		15.2～17.4	16.4	10	
'49	27	7.5～10.1	8.3	50	C
'53	29	21.0～28.0	23.3	86	A
〃	5	22.0～28.2	24.7	50	A
		25.3～28.4	26.4	10	
'50	7	8.2～12.3	10.2	55	A
〃 Aug.	11	17.5～27.5	22.9	76	A
'53	18	16.0～25.1	20.2	114	A
'49	24	9.1～12.1	10.0	37	C
'50	24	10.5～11.3	10.9	7	C
'48	25	7.5～11.1	9.1	60	C
'53	1	24.0～28.0	25.8	65	A
'49	8	8.5～11.7	9.6	21	C
		8.3～11.5	9.4	50	
'50	8	11.4～18.0	14.5	50	D
		19.4～26.2	22.7		
'48 Sep.	13	8.0～10.0	8.9	67	B
'49	17	8.4～11.4	9.2	50	B
'50	19	11.6～20.2	15.9	27	D
'48	23	8.2～10.7	9.4	50	B
'50	23	23.0～27.0	25.0	18	A
		29.0	—	1	
'48	28	9.0～10.7	9.4	50	B
'50	3	23.0～27.0	25.5	21	A
		1.4～ 3.9	2.8	42	E
〃 Oct.	8	14.0～16.0	15.0	4	A
		18.0～27.0	24.0	29	
〃	10	12.0～19.6	15.8	23	D
'49	14	16.4～18.7	17.6	25	B
'50	21	20.2～26.5	23.6	25	A
'48	2	9.1～11.2	9.9	50	B
'50 Nov.	14	13.0～20.0	18.0	34	D
〃	24	11.0～14.0	13.0	23	A
'48	24	9.7～14.3	11.1	50	B
'50	9	13.0～21.0	18.6	26	D
〃 Dec.	14	12.0～14.0	13.9	29	A
〃	19	11.0～12.8	12.1	15	A
〃	21	11.5～14.0	13.0	20	A

るが，これを基にし直ちに成長を追跡することは，体長分布が非常に変異があり複雑であるから確実性を欠くことになる。更に塚原等 (1955) によると発生時期によつて，大島(未発表)による

と棲息環境* によつてその成長度に大きな相違がみられることも考慮しなければならない。

三田（1957）によれば日向灘・豊後水道附近のマアジの稚魚の出現は春季（2月・3月）と秋季（8月～11月）の2回に多く認められている。従つて4月のA群及び 10 月のF群が夫々春秋両季の産卵時期のものと関連する様であるが，マアジの若年魚以上の出現状態からいつて，その産卵場・産卵期が頗る広範囲に亘り，しかも非常に長期間に亘つていることが伺われる。A・A′. B・E・C・Dの各群の夫々の関係については今後の研究に俟たなければならない。

摘　　要

徳島県沿海に於けるマアジの出現状況を調査し次の様な結果が得られた。

（1） 徳島県沿海は地理的にみて純内海性の播磨灘と純外海性の太平洋側とその中間性の紀伊水道側の3海区に区分され，マアジの小型魚は各海区共に洄游するが，大型魚は太平洋側と紀伊水道側南部に限定される。

（2） 大体周年太平洋側では漁獲があるが，量的に多い時期は春季（4月～6月）と秋季（9月～11月）の2回で，この両季の漁獲物の大部分は体長 20cm 以上の大型魚である。7月・8月には体長 10cm から 20cm 迄の小型のアジが相当量定置網で漁獲される。アジ仔（体長 5cm 以下）は4月末から7月にかけて好漁である。

（3） マアジの仔魚（幼魚）は春・秋2回みられ，年2回の産卵が伺えるが，体長組成からみると，群によつて或は時期によつて非常に変異があり，複雑な様相を示すので，マアジの産卵は広範囲且つ長期間に亘るものと思われる。

文　　献

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* 東大大島教授の御教示による

Résumé

The present paper deals with the horse mackerel, *Trachurus japonicus*, in the vicinity of Hiwasa, which is located at the Pacific coast of Tokushima Prefecture, and both the seasonal change of catch and size composition of the fish in the several gears are considered.

The monthly change of the catch has indicated the existence of two considerably high peaks, viz. the peak in spring (April to June) and that of autumn (September to November). The catch of the former was more abundant than that of the latter and the catch in both seasons was occupied by the larger fish (over 20 cm in body length). The smaller fish (10 cm to 15 cm in body length) appeared in summer (July and August) and the very small fish (under 5 cm in body length) in both April and October. Therefore, the numder of spawning seasons was estimated as twice in a year. But the size-composition has indicated a considerable variation by fish-shool and with time of catch.

Judging from the monthly length-composition mentioned above, it is presumed that the spawning grounds were wide-spread and the spawning season extended over a long period.

New, Rare or Uncommon Fishes from Japanese Waters. VI.

Notes on the Rare Fishes of the Family *Histiopteridae*.

(*Continued from vol. vi, nos. 1/2, p. 39*)

Tokiharu ABE

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D. XIV 8 (all soft fin-rays branched) in 1 specimen ; XIV 9 (all soft fin-rays branched) in 3 specimens ; XV 8 (all soft fin-rays branched) in 1 specimen ; in all specimens hindmost soft fin-ray bifid to base, and more or less close to penultimate ray.

A. IV 7 in 3 specimens (in 1 specimen only 1st soft fin-ray unbranched ; otherwise soft fin-rays all branched) ; IV 8 (all soft fin-rays branched) in 2 specimens ; in all specimens hindmost soft fin-ray bifid to base, and more or less close to penultimate ray.

P. $\left\{\begin{matrix}17\ (=ii+14+i)\ \text{(left)}\\ 17\ (=ii+14+i)\ \text{(right)}\end{matrix}\right\}$ in 1 specimen, $\left\{\begin{matrix}17\ (=ii+15)\ \text{(left)}\\ 18\ (=ii+15+i)\ \text{(right)}\end{matrix}\right\}$ in 1 specimen,

$\left\{\begin{matrix}17\ (=ii+14+i)\ \text{(left)}\\ 17\ (=ii+14+i)\ \text{(right)}\end{matrix}\right\}$ in 1 specimen, $\left\{\begin{matrix}18\ (=ii+14+ii)\ \text{(left)}\\ 17\ (=ii+14+i\ )\ \text{(right)}\end{matrix}\right\}$ in 1 specimen,

$\left\{\begin{matrix}18\ (=ii+15+i)\ \text{(left)}\\ 18\ (=ii+15+i)\ \text{(right)}\end{matrix}\right\}$ in 1 specimen.

V. I 5 (all soft fin-rays branched) in 4 specimens ; the fins damaged in 1 specimen.

Branchiostegals 4+3 (left) and 4+3 (right) in 4 specimens ; 3 (uppermost abnormally branched)+3 (left) and 4+3 (right) in 1 specimen.

Inner fold of branchiostegal membrane of right side laps over the left one in 2 specimens ; inner fold of branchiostegal membrane of left side laps over right one in 2 specimens ; these membranes damaged in 1 specimen.

Number of gill-rakers on 1st arch 7+1+16 (left) and 7+1+17 (right) in 1 specimen ; 6+1+17 (left) and 7+17 (right) in 1 specimen ; 8+1+16 (left) and 7+1+16 (right) in 1 specimen ; 7+1+17 on both sides in 1 speimen ; gill rakers damaged in 1 specimen.

Notes on an additional example on loan from Mr. T. Masuda. After the foregoing went to press, an adult example of the present species taken off Amatsu (south-eastern coast of Bōsō Peninsula) has been received on loan from Mr. T. MASUDA (Kominato Marine Station). It was sent to him from the Fishermen's Association at the town of Amatsu for identification. Exact data of the specimen are not available, but, judging from the information from him, it is probable that the fish was taken along with the examples mentioned above. Total length 378 mm, fork length 374 mm, standard length 325 mm. Adult male.

D. XIV 9 (all soft fin-rays branched ; 9th ray bifid to base and slightly closer to 8th than 7th does to 8th. 2nd spine is not on the mid-dorsal line, but slightly left to it ; 3rd

spine is not on the mid-dorsal line, but slightly right to it).

A. IV 8 (all soft fin-rays branched ; 8th ray bifid to base, not close to 7th. Position and direction of 2nd and 3rd spines as in 2nd and 3rd dorsal spines).

P. 17 (=ii+14+i) (left) and 17 (=ii+13+ii) (right) (4th and 5th rays longest).

V. I 5 (all soft fin-rays branched ; excepting for spine, mostly black).

Left branchiostegal membrane laps over the right. Branchiostegals 4+3 on both sides. Gills 4 ; a slit behind 4th. Pseudobranchiae well developed. Gill-rakers short ; their number 7+18 on both sides. Peritoneum black. Posterior margin of operculum smooth. Lower margin of preoperculum finely serrated ; only lower part of hind margin of this bone with slightly rough serrations.

B. *Pseudopentaceros richardsoni* (SMITH) from Hachijō Island (Fig. 1). As stated above (foot-note on p. 35), a fine specimen of this rare species (Cat. No. ABE 10552), collected by Mr. KUSAKARI, has been presented to the writer for study. It was taken near the island, probably by hook and line, in 1952 or 1953. Total length *ca.* 354 mm, fork length *ca.* 340 mm, standard length *ca.* 298 mm.

D. XIV 9 (all soft fin-rays branched ; 9th fin-ray bifid to base, more or less close to 8th fin-ray ; 3rd spine longest, its length 47 mm ; 4th spine seemingly damaged ; hind-most spine loger than penultimate spine as in all specimens mentioned above ; 2nd spine is not on the mid-dorsal spine, but originates slightly from the right of the line ; 3rd spine is on the left side of the mid-dorsal line).

A. IV 7 (all soft fin-rays branched ; 7th fin-ray bifid to base ; more or less close to 6th fin-ray ; 2nd spine originating slightly from the left to the mid-ventral line).

P. 17 (=ii+14+i) (left) and 17 (=ii+15) (right).

Fig. 1. *Pseudopentaceros richardsoni* (SMITH) from Hachijō I., south of Sagami Bay. Total length *ca.* 354 mm.

V. I 5 (all soft fin-rays branched).

The right branchiostegal membrane laps over the left. Branchiostegals 4+3, on both sides.

C. A young example of "Tsubodai" *Quinquarius japonicus* (DÖDERLEIN) from near Torishima. A fine young example of this species (Cat. No. ABE 10555) was caught in a drifting gill-net for the giant spring flying-fish, *Cypselurus pinnatibarbatus japonicus* (FRANZ), near Torishima (a small island south of Hachijō Island), in the night, early in March, 1954, and presented to the writer for study by the Ōshima Branch Station, Fisheries Experiment Station of Tokyo Prefecture. He wishes to express here his sincere thanks to the biologists at the station for their co-operation with him. The specimen measures 53 mm in total length, and 45.5 mm in standard length. Length of head 17 mm, greatest depth of body (at dorsal origin) 28 mm, least depth of caudal peduncle 6.7 mm, distance between outer (or anterior) ends of ventral bases 13 mm, horizontal diameter of orbit 5.7 mm on both sides, vertical diameter of orbit 5.7 mm (left) and 5.5 mm (right), interorbital width at anterior ends of orbits 5 mm, interorbital width above eye-centers (including bony projection) *ca.* 8 mm, length of snout 5.8 mm on both sides.

D. XII 14 (=13+i ; 13th and 14th fin-rays close together ; 2nd spine originates from left side of mid-dorsal line ; 3rd spine originates from right side of mid-dorsal line, and so on).

A. V 10 (all soft fin-rays branched or 9+i ; 9th and 10th fin-rays close together).

P. 17 (tips damaged) (left) and 17 (uppermost 1 or 2 fin-rays and lowermost 1 or 2 fin-rays unbranched, the other fin-rays branched ; 1st fin-ray shorter than 1/2 of length 2nd fin-ray).

V. I 5 (all fin-rays branched) on both sides.

Scales hard, thick, and nearly juxtaposed. Lateral line strongly arched below dorsal spines ; there are 3 or 4 scale rows between the top of the arch of lateral line and upper edge of the groove receiving dorsal spines.

Posterior margin of operculum smooth. Preoperculum ventrally with rough denticulations which are the termination of the striae of the bone.

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